UCRL-JC-120525 Abs

An adaptive optics system for solid–state laser systems used in inertial confinement fusion

J. T. Salmon, E. S. Bliss, J. L. Byrd, M. Feldman, M. A. Kartz,
J. S. Toeppen, B. VanWonterghem, and S. E. Winters
Lawrence Livermore National Laboratory
P. O. Box 808, MS L-463 Livermore, CA 94551

	Telephone	FAX	E-mail
J. T. Salmon	510-422-9529	510-423-3143	salmon2@llnl.gov
E. S. Bliss	510-422-5483	510-423-3143	bliss1@llnl.gov
J. L. Byrd	510-422-6072	510-422-2237	byrd1@llnl.gov
M. Feldman	510-423-6854	510-423-3143	feldman1@llnl.gov
M. W. Kartz	510-422-9445	510-422-7558	kartz1@llnl.gov
J. S. Toeppen	510-422-8583	510-423-3143	toeppen1@llnl.gov
B. M. VanWonterghem	510-423-9494	510-422-7748	vanwonterghem1@llnl.gov
S. E. Winters	510-422-6767	510-423-3143	winters4@llnl.gov

Abstract

We have obtained nearly diffraction-limited 2.5 kJ, 3 nsec output pulses at 1.053 mm from the Beamlet laser using adaptive optics. Beamlet is a demonstration system supporting technology development for the National Ignition Facility.

The adaptive optic components are located as shown in the figure on the next page. The 7 cm square deformable mirror has 39 actuators forming equilateral triangular subapertures. The substrate is continuous with actuators attached to posts on the back of the substrate. The influence function of the interior actuators is roughly Gaussian with 1/e half-width about equal to the separation between actuators, and the stroke is sufficient to correct ± 5 waves of astigmatism at 1.053 mm.

The system optical design provides an image of the deformable mirror on each Hartmann sensor. The sensors use standard black & white video cameras and photolithographically produced arrays of 77 lenslets. The focal ratio of each lenslet is 81.5 with a Fresnel number of 1.1, and the size of each Hartmann spot is equal to half the lenslet diameter. The CCD array is centered within the depth of focus of the lenslets, which minimizes the sensitivity of the centroids of the Hartmann spots to variations in the intensity distribution across each lenslet.

*Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48

The adaptive optics system can flatten the wavefront at the location of either Hartmann sensor with either cw light or with pulsed light from a regenerative amplifier in the front end. The system can also prefigure the wavefront of the beam to the conjugate of a wavefront specified by the user. Furthermore, the system can capture an image of Hartmann spots during a main system shot, and the data can be used to improve the prefigure applied on subsequent shots. The current closed-loop

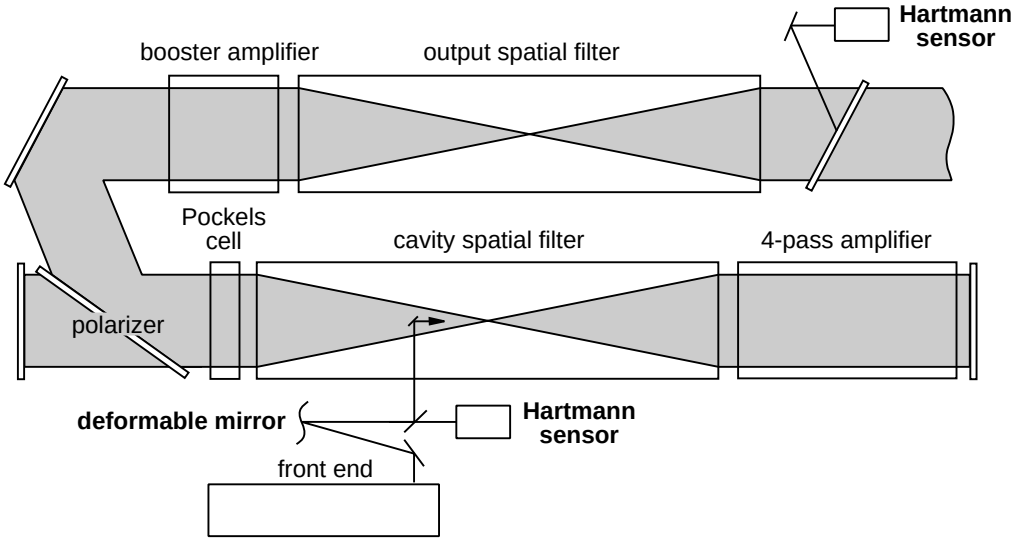

Figure. The Beamlet laser chain with bold labels identifying adaptive optics components

system bandwidth is about 1/2 Hz for cw light and about 1/50 Hz for regenerative amplifier light. An additional Hartmann sensor with 247 lenslets is located adjacent to the output Hartmann sensor for more detailed diagnostic measurements.

With precorrection we have reduced the total aberrations in Beamlet output pulses to less than 0.2 waves rms, including compensation for static errors, slowly changing thermally induced errors, and dynamic pump-induced errors from the shots themselves. We will discuss several aspects of this work, including the method of sensor calibration, system limitations owing to turbulence in the beam line, and measurements of the evolution and decay of thermally induced aberrations between shots. Results to date reinforce the expectation that active wavefront correction is required for future inertial confinement fusion drivers such as the National Ignition Facility.